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Two experiments studied the influence of an individual's cognitive style on concept identification. Subjects were high school males, classified into levels of cognitive style according to their performance on the Hidden Figures Test. For the first experiment, three non-overlapping groups of 30 each were required to classify figural patterns, which could vary along as many as seven bilingual dimensions, into four categories. Findings were that high analytic subjects made fewer errors than did middle analytic subjects who in turn made fewer errors than the low analytic; performance in terms of error-to-criterion was an increasing linear function of the complexity of the problem ($p<.01$); and the interaction of cognitive style with complexity was not significant. For the second experiment, two groups of 40 each were selected and 10 subjects from each level of cognitive style were randomly assigned to one of four training conditions (verbal-prompt, prompt, verbal, and control). Results indicated that high analytic subjects committed fewer errors that low analytic subjects ($p<.05$); verbalizing the stimulus values facilitated concept identification only in the absence of prompted training; prompted training facilitated identification only in the absence of verbal training; and training procedures did not differentially influence performance of subjects with different cognitive styles. (Author/JD)

CONCEPT IDENTIFICATION AS A FUNCTION OF COGNITIVE STYLE, COMPLEXITY, AND TRAINING PROCEDURES

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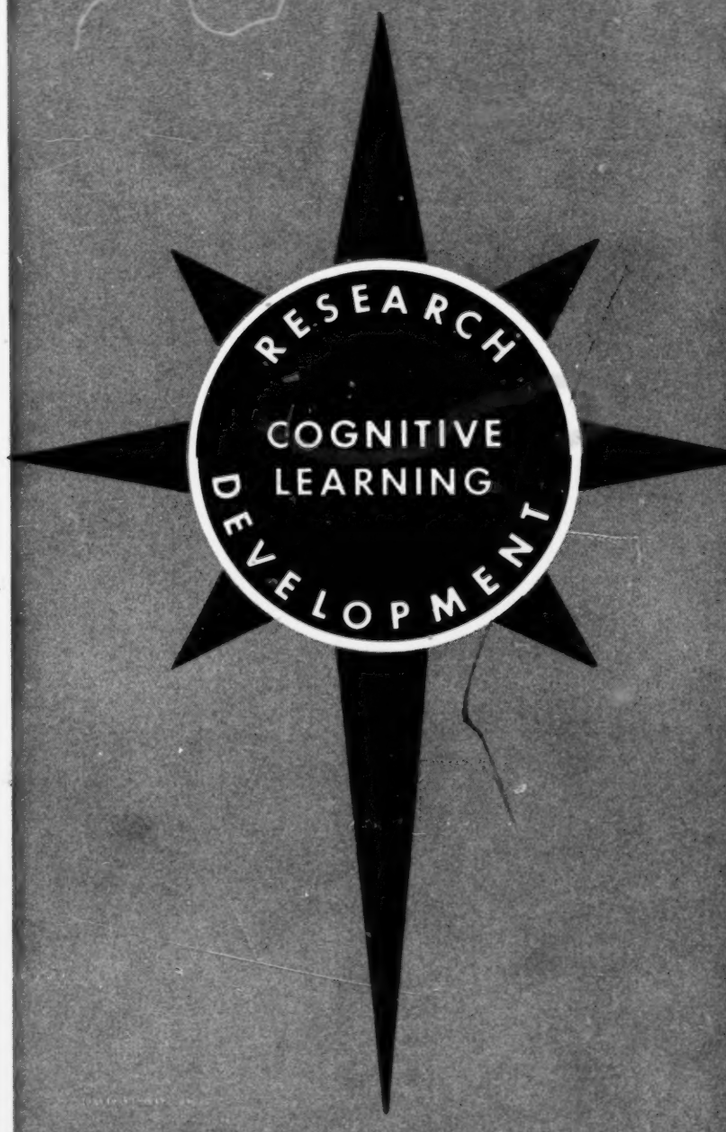

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Technical Report No. 32

CONCEPT IDENTIFICATION AS A FUNCTION OF COGNITIVE STYLE, COMPLEXITY, AND TRAINING PROCEDURES

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PREFACE

This technical report is based upon the dissertation of J. Kent Davis. The examining committee consisted of Professors Herbert J. Klausmeier (chairman), Gary A. Davis, Frank H. Farley, Harold J. Fletcher, and Edward A. Nelson.

One major program of the Wisconsin R and D Center for Cognitive Learning is Program 1 which is concerned with fundamental conditions and processes of learning. This Program consists of laboratory-type research projects, each independently concentrating on certain basic organismic or situational determinants of cognitive learning, but all united in the task of providing knowledge which can be effectively utilized in the construction of instructional systems for tomorrow's schools.

Of critical importance to the field of human learning is the area of concept learning, an area which enjoys vigorous experimentation, most of which is designed primarily to reveal task or situational determinants of performance. Mr. Davis continues these empirical investigations by examining effects of stimulus complexity and training variables, but, significantly, he provides information relating an organismic factor, "cognitive style," to concept identification ability in high school males. The results of Mr. Davis' research underscore the importance of considering differences in cognitive style of individuals attempting to solve conceptual problems.

Harold J. Fletcher
Director, Program 1

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ABSTRACT

The influence of an individual's cognitive style, operationally defined in terms of performance on the Hidden Figures Test (HFT), in concept identification was studied as a function of task complexity in one experiment and as a function of two training procedures in another experiment. Th concept identification task required S to classify figural patterns, which could vary along as many as seven bi-valued dimensions, into four categories, each representing one of four possible combinations of values from two relevant dimensions. Subjects were tested individually and run to a criterion of 16 consecutive correct responses.

For Experiment I, three non-overlapping groups of 30 senior high school males each were selected on the basis of HFT scores. Three levels of task complexity, three levels of cognitive style, and two problems were factorially combined to form a 3 × 3 × 2 design. Five Ss from each of the three levels of cognitive style were randomly assigned to the problem by complexity treatment conditions. The essential findings were: (1) High analytic Ss made fewer errors than did middle analytic Ss who in turn made fewer errors than low analytic Ss. (2) Performance in terms of errors-to-criterion was an increasing linear function of the complexity of the problem. (3) The hypothesized interaction of Cognitive Style with Complexity was not significant.

For Experiment II, two groups of 40 senior high school males each were selected on the basis of HFT scores. Ten Ss from each level of cognitive style were randomly assigned to one of the following four training conditions: verbal-prompt, prompt only, verbal only, and control (no training). The essential findings were: (1) High analytic Ss committed significantly fewer errors than low analytic Ss. (2) Verbalizing the stimulus values for each instance facilitated concept identification, but only in the absence of prompted training. (3) Prompted training facilitated concept identification, but only in the absence of verbal training. (4) The training procedures did not differentially influence performance of Ss functioning under different cognitive styles.

I
INTRODUCTION

It is well documented that there are large individual differences in the manner in which people perceive and analyze a complex stimulus configuration and that this particular manner or style carries over into other areas of cognitive functioning. Furthermore, there is a growing body of literature which suggests that individual differences in perceptual and conceptual organization are relatively stable and interact to produce consistencies in cognitive functioning.

The term cognitive style has been used to refer to individual consistencies in cognitive behavior resulting from the individual's perceptual and conceptual organization of the external environment (Kagan, Moss, & Sigel, 1963). Various other terms such as cognitive control, cognitive system-principles, and perceptual attitudes have been used to label essentially the same phenomenon.

A number of different dimensions have been suggested within the rather general domain of cognitive style. There is one characteristic, however, which is common to a number of these dimensions. Although various labels are applied to this characteristic, it is concerned primarily with the manner in which an individual perceives and analyzes a complex stimulus configuration. The two poles of this dimension are characterized by subjects (Ss) who analyze and differentiate the components of the stimulus complex and by Ss who fail to analyze and differentiate the components and respond to the "stimulus-as-a-whole." Kagen et al. (1963) classified the former Ss as analytical and the latter as relational and believed that their classification system was similar to the field independent-dependent classification of Witkin, Lewis, Hertzman, Machover, Meissner, and Wapner (1954). A similar classification system was suggested by Gardner (1953) in which the continuum was described as ranging from differentiated Ss to undifferentiated Ss. Thus, there appears to be one dimension which involves an active analysis on the one hand and a more passive, global acceptance of the entire stimulus on the other hand.

Although previous interest in cognitive style has focused essentially on the relationships between cognitive style and personality structures and certain demographic relationships, it has been suggested that cognitive style has wide implications for a variety of areas including education (Witkin, 1965). The data from a number of studies concerned with cognitive style suggest that a person's cognitive style influences the quality of cognitive products involved in a variety of tasks such as paired-associate tasks (Kagan et al., 1963), memory tasks (Gardner & Long, 1961), vigilance tasks (Kagan et al., 1963), and problem solving tasks (Witkin, 1964). A study by Baggaley (1955) suggested that cognitive style was also a significant variable in concept identification. In this study, Ss were presented cards that varied along five bivalued dimensions and were asked to identify two dimensions which were relevant to classifying the cards. Baggaley found that Ss who performed in an analytic manner on the Concealed Figures Test also performed significantly better on the concept identification task than did Ss who performed in a more global manner on the Concealed Figures Test.

Since the majority of concept identification tasks require selective attention to relevant aspects of complex stimulus configurations, it would seem that further research on the nature of cognitive style in concept identification is necessary. The present experiments were designed to examine further the extent to which an individual's cognitive style influences his performance on a standard concept identification task. The operational index of the analytic-global dimension of cognitive style employed in the present studies was performance on the Hidden Figures Test (HFT). It was assumed that Ss able to identify the hidden figures represented the analytic end of the continuum, while Ss unable to identify the hidden figures represented the global end of the continuum.

The first study was designed to consider the relationship between cognitive style and performance on concept identification problems of varying levels of complexity. It was hypothesized that individuals experiencing difficulty in locating hidden figures on the HFT would also experience difficulty in identifying concepts in a concept identification task. The purpose of the second experiment was to determine to what extent training procedures would facilitate the identification of concepts. It was hypothesized that the training procedures would facilitate concept identification for all Ss, but that the degree of facilitation would be greater for the non-analytic Ss. Effective laws of conceptual behavior can only be formulated when the relationship between individual differences and cognitive tasks are fully understood. It is hoped that the results of these studies provide some information pertaining to individual differences and training procedures in concept identification.

II
RELATED RESEARCH

THEORETICAL FORMULATIONS CONCERNING COGNITIVE STYLE

The topic of cognitive style has recently attracted a good deal of interest on the part of personality psychologists, social psychologists, and psychometricians. These psychologists have repeatedly observed marked individual differences in both perceptual and cognitive activities. Much of the cognitive style research has focused on a dimension of cognitive style which is concerned with individual differences in analysis of complex stimulus configurations. With respect to this dimension the following approaches can be distinguished: (1) the work of Witkin on field independence and dependence, (2) the work of Kagan on styles of conceptualization and (3) the work of Gardner on cognitive controls. Since the primary concern of this paper is the relationship between cognitive style and learning, relatively little emphasis will be given to the relationship between cognitive style and personality.

Field Independence and Dependence

In a series of experiments (Asch & Witkin, 1948a, 1948b; Witkin, 1949a, 1949b; Witkin & Asch, 1948a, 1948b) concerned with the perception of the upright, Witkin noted incidentally that there were marked individual differences in the way people orient themselves in space. Some individuals perceived the upright largely on the basis of the visual field while others perceived the upright largely on the basis of kinesthetic cues at the exclusion of the visual field. Furthermore, women were found to be more dependent upon the visual field than men. These findings suggested to Witkin that a full understanding of perception for the upright could be achieved only by determining the variables responsible for these individual differences.

In a large-scale study, Witkin et al. (1954) examined these individual differences in perception. The primary objectives of the study were to determine the extent to which individual differences in perception were (1) self-consistent, (2) related to personality, and (3) changed with developmental levels. In order to meet these objectives three separate samples were employed—a normal sample consisting of male and female adults, a hospitalized sample consisting of male and female psychiatric patients, and a developmental sample consisting of boys and girls at various age levels ranging from 8 to 17 years.

Subjects within each of the samples were administered two major test batteries—a perceptual battery and a personality battery. The extent to which individual differences in perception were self-consistent was assessed by intercorrelating performance on a series of perceptual tasks which included the Rod and Frame Test (RFT), Body Adjustment Test (BAT), and the Embedded Figures Test (EFT). In the RFT the S was presented an illuminated frame containing an illuminated rod. Both the rod and frame could be rotated independently, and the S's task was to orient the rod to the true vertical. In the BAT, a S sat on a chair in a room designed in such a way that both the chair and room could be tilted independently. The S's task was to orient the chair or the room to an upright position. The S's task on the EFT was to locate a simple figure embedded in a complex design, the dependent variable being the amount of time taken to locate the simple figure.

Results with the normal sample showed that individuals tended to be self-consistent in their perceptual functioning under quite different situations. Subjects who adjusted the rod more or less to the axes of the tilted frame in the RFT tended to align their chairs with the surrounding field in the BAT and took longer to locate the simple figure in the EFT. Others who adjusted the rod more or less to the true vertical regardless of the orientation of the frame in the RFT tended to align their chairs with the true vertical in the BAT and located

the simple figures in the EFT in a relatively short period of time. The individual differences observed in the earlier perceptual studies were, therefore, attributed to the degree of dependence on the prevailing visual field. This relationship was described as a continuum ranging from great dependence at one extreme to great independence at the other extreme. Subjects able to overcome the influence of the surrounding perceptual field were described as field independent while Ss strongly influenced by the perceptual field were described as field dependent.

Similar results were reported for the hospital sample; however, one major difference was observed. Hospitalized males were found to concentrate at the extremes of the field independent-dependent continuum. This contrasted sharply with the over-all distribution for the normal sample in which the majority of Ss were intermediate. The distribution for hospitalized females also showed a marked concentration at the extremes, with the majority at the field-dependent end of the continuum.

Correlations of perceptual-test scores with personality-test scores clearly demonstrated relationships between personality and perception. For example, Ss identified as field dependent on the basis of perceptual performance were found, on the basis of clinical interviews, to "lack insight, repress their impulses, to be passive, to yield to their inferiority feelings, and to be tense [p. 203]." Subjects classified as field independent yielded an opposite picture in that they tended to "show self-awareness, to express their impulses directly, to be active, to deal with inferiority feelings in a compensatory way and to show self-assurance [pp. 203–204]." Similar results were obtained using other personality measures such as the Rorschach and Thematic Apperception Test.

Perceptual and personality results with the developmental sample were consistent with the findings of the adult samples. Individuals at all age levels were self-consistent in their perception. Furthermore, females at all ages were found to be more field dependent than males. One major difference, however, was that the younger children as a group tended to be more field dependent than older children. The perceptual-personality relationships observed with adults were, for the most part, present in children of the developmental sample.

Witkin et al. (1954) concluded that the nature of the visual perceptual field has a very strong influence upon perception. In perceptual tasks in which an item must be separated from the context in which it is embedded pronounced individual differences occur. A continuum describing the range of these individual differences was identified in which the extremes of the continuum were represented by field-dependent perceptual performances and field-independent perceptual performances. Furthermore, Witkin et al. (1954) found that individual differences in perception were associated with differences in other areas of psychological functioning; field dependence was found to be associated with a passive, global way of experiencing the environment, while field independence was characterized as an active analytic way of experiencing the environment.

Subsequent studies by Witkin and his colleagues (Faterson, 1962; Witkin, 1964; Witkin, Dyk, Faterson, Goodenough, & Karp, 1962) led to the expansion and modification of this general notion of a field-independent-dependent dimension of cognitive style. Witkin et al. (1962) reported a number of studies designed primarily to determine the antecedent conditions which resulted in the development of field-independent or field-dependent behavior. The results of these studies, many of them confirming earlier observations, implied that the terms field independence and field dependence were not appropriate because of the emphasis upon perception. Accordingly, the designation analytic-global field approach was adopted to represent a broader dimension of cognitive functioning. Thus, Witkin believed that an individual's perception was but one component of a larger constellation of interrelated components which together reflected an individual's level of psychological differentiation.

Styles of Conceptualization

Kagan et al. (1963) began their investigation of cognitive style following an observation that individuals differed greatly when asked to sort an array of human figures into meaningful groups. A dimension similar to Witkin's field independence and dependence was observed in which one extreme was represented by Ss who grouped the figures on the basis of a shared element while the other extreme was represented by Ss who grouped the figures on the basis of functional relationships between the figures. Subjects identified as analytical selected specific subelements of the human figures as the primary basis for grouping. In effect, these Ss separated

the figure or the subelement from the ground. In contrast, the relational Ss treated each stimulus as a whole and grouped the human figures on the basis of a relationship between the figures. The investigators viewed the former type of grouping as requiring the greatest amount of stimulus analysis.

These observations led to the developmental analysis of preferences for analytical categorizations. In order to obtain information concerning the antecedent conditions that influenced the development and maintenance of analytic grouping, a new measuring device was developed which could be employed with children. This test, the Conceptual Style Test (CST), consisted of 30 sets of three drawings of familiar objects. The S's task was to group two of the three objects together and explain the basis of grouping. For each set of stimuli, two major types of responses were possible, either an analytical or relational type of response. The dependent variable was the number of analytic responses given to the 30 sets of stimuli.

The generality of the analytic construct was noted by the Kagan group in their finding that children performing analytically on the CST tended to be analytical in other test situations. For example, sixth-grade boys who were analytical on the CST tended to sort human figures in an analytical fashion. The correlation between the CST and the figure sort was .37 ($p < .05$). In a word association test, analytical boys produced more noun responses to noun stimuli. Also in a serial learning task, analytical boys tended to recall words according to conceptual groups. The opposite findings were observed in the non-analytic or relational boys; they produced more noun-verb relationships in the word association task and recalled more of the functionally related words on the serial learning task. Similar results were obtained with a sample of third-grade boys.

Kagan et al. (1963) hypothesized that an analytic style would result in greater differentiation of complex stimulus arrays than would a non-analytic style. As a test of this hypothesis, analytic and non-analytic Ss were given a paired-associate task in which the stimulus components were geometric stimuli that had distinct figure-ground relationships. After the Ss learned to associate nonsense syllables to these stimuli, they were required to give the nonsense syllable response to the figure and ground elements separately. Analytic children made fewer errors than non-analytic children when the figure was presented alone. Also, girls made more errors than boys. Essentially the same results were obtained for the situation where the ground element was presented alone, but they did not reach an acceptable level of significance. These data suggested that the analytic child tended to separate the irrelevant from the relevant and differentiated the stimulus environment. Further support for this conclusion was obtained from an analysis of ambiguous stimuli—ink blots. Analytic children described ink blots in a more analytical fashion than did non-analytic children.

Furthermore, it was observed that analytic Ss devoted more time to scanning the stimulus objects in the CST. An analysis of response latencies on the CST showed that, on the average, 5.4 seconds were devoted to giving analytic responses, while only 4.0 seconds were devoted to giving relational responses. Thus, it was concluded that the analytical style was indicative of a reflective approach to conceptual analysis and a non-analytical style was associated with a more compulsive manner of responding. Analysis of the response times on the TAT and ink blots provided further support for this notion.

The results of this series of investigations suggested to Kagan et al. (1963) that an individual's preferred cognitive style was influential in a wide variety of situations ranging from the production of word associations to simple reaction time tasks. Furthermore, individuals were found to be relatively consistent in their style of responding across these various situations; thus, if an individual responded in an analytical fashion on the CST he tended to respond in an analytical fashion when sorting human figures, interpreting ambiguous stimuli such as ink blots, and so forth. It was concluded that the analytic—non-analytic mode of responding corresponded to a dimension of cognitive style representing the ability to differentiate relevant from irrelevant cues.

Kagan, Rosman, Day, Albert, and Phillips (1964) extended the earlier work of Kagan et al. (1963). A series of eight separate studies was conducted using grade school children as Ss. The data from these studies prompted Kagan et al. (1964) to conclude that the analytic—non-analytic style of responding was related to two major variables—the tendency to analyze and differentiate a complex stimulus configuration into its component parts and the tendency to inhibit impulsive responses.

The reflection-impulsivity variable was observed in simple discrimination situations in which a number of response alternatives were available to the S. In the Design Recall

Test (DRT), for example, a S was presented a simple geometric design followed by 12 variants of this standard and was asked to identify which of the 12 designs was identical to the standard. Kagan et al. (1964) reported that Ss who responded in an analytic style on the CST tended to delay their response on the DRT; but when they did respond their initial response was correct. In contrast, the non-analytic responders on the CST tended to have short response latencies but were more likely to commit an error on their initial response. Thus, the impulsive Ss made rapid decisions and consequently more errors than the reflective Ss who delayed their initial response and were more accurate.

In summary, Kagan and his colleagues have suggested a dimension of cognitive style which appears to be similar to that suggested by Witkin. Both approaches have stressed an individual difference variable which is related to the manner in which a complex stimulus array is perceived and analyzed. Subsequent research by Kagan (1965) has focused primarily on the reflection-impulsivity variable and has placed less emphasis upon individual differences in the degree of stimulus differentiation.

Cognitive Controls

A third approach to cognitive style is represented by the work of Gardner and his colleagues (Gardner, 1962, 1964; Gardner, Holtzman, Klein, Linton, & Spense, 1959; Gardner, Jackson, & Messick, 1960; Klein, 1954). A central theme of this point of view is that personality organization, called cognitive controls, is thought to account for an individual's mode of perceiving, remembering, and thinking. Cognitive style is thus viewed as a composition of cognitive controls.

These investigators have devoted much of their research activity to the identification and clarification of the cognitive controls, but have given little empirical consideration to cognitive style as represented by patternings of these cognitive controls. Five major cognitive control principles have been suggested: leveling-sharpening, tolerance for unrealistic experiences, equivalence range, focusing or scanning, and constricted-flexible.

A factor analytic study was conducted by Gardner et al. (1959) to test the adequacy of the formulations of the five control principles and Witkin's field independent-dependent dimension. The objectives of this study were to develop precise descriptions and operational definitions of cognitive controls and to identify tasks and adaptive situations to which these control principles were related. Thirty adult males and 30 adult females were administered a battery of tests thought to be related to the five cognitive control principles and to Witkin's field independent-dependent dimension. Separate factor analyses were performed for males and females and each analysis was based upon 40 scales thought to be related to the cognitive controls.

For men, five factors were extracted which accounted for 39.6% of the total score variance. Only two of the factors, however, were interpreted. Factor I accounted for 12.3% of the score variance and resembled the scanning control principle. Factor IV accounted for 7.5% of the score variance and corresponded to the control principle of tolerance for unrealistic experiences.

The scanning control principle of Factor I represented the degree of "attention deployment." The two extremes of this dimension were represented by Ss who actively scanned the stimulus field and by Ss who were much more restrictive in scanning a stimulus field. Subjects with high factor scores were less restrictive in terms of their free associations on a word association task, they made stable size judgments on a size estimation test, they made relatively large errors on the RFT and located the hidden figures in the HFT in a short period of time. Subjects with low factor scores presented the opposite pattern of responding on these tests. They were more limited in the range of words used in the word association tasks, size estimations were unstable and quite variable, they were relatively accurate in the RFT and experienced difficulty in locating the hidden figures in the HFT.

Factor IV corresponded to the control principle of tolerance for unrealistic experiences in which the extremes were represented by Ss who were unaffected by perceptual experiences contrary to what was known to be "objectively true" versus Ss who were bothered by such experiences. Most of the tests which identified this control were perceptual tasks such as the Apparent Movement Test.

For women, six factors were extracted which accounted for 56.1% of the total score variance. Only three of the factors, however, were interpreted. Factor I accounted for 15.3% of the score variance and was viewed as representing the field independence-dependence dimension and the constricted-flexible control principle. Factor II accounted for 11.7% of the score variance and corresponded to the leveling-sharpening control principle. Factor III represented the equivalence range principle and accounted for 6.8% of the test variance.

Due to the factor loadings of Factor I, Gardner et al. (1959) suggested that the variables associated with field independence-dependence and constricted-flexible control be subsumed under a single control principle—field articulation. Women with high factor scores experienced difficulty on tasks which required responding selectively to relevant cues. In these situations they tended to respond to the most compelling cues, ignoring others. They made large errors on the RFT; they were unable to locate the embedded figures in the HPT; they were very restrictive on the free association tests and experienced difficulty on the Color Word Test (CWT). In contrast to the high factor scorers, low factor scorers were highly successful in the RFT and the EFT, quite fluent in their free associations, and experienced little difficulty in the CWT. Furthermore, the investigators observed results on the Rorschach Test which were similar to those reported by Witkin et al. (1954).

These findings led to the conclusion that the field articulation dimension was dealing with the ability to differentially attend to relevant aspects of a stimulus complex rather than the ability to separate an item from an embedded context as Witkin had originally suggested.

The control principle of leveling-sharpening was represented by Factor II for women. This principle was observed in situations involving memory for sequentially presented stimuli. Levelers showed a relatively undifferentiated memory for successive stimuli while the sharpeners maintained relatively detailed memory for successive stimuli. Also the levelers were characterized as being more susceptible to assimilation effects.

Factor III corresponded to the control principle of equivalence range. This factor was observed in test situations, such as the Object Sorting Test (OST), which required a S to categorize stimuli. Some individuals (broad equivalence range) sorted stimuli into few categories and their criterion for sorting was very general. Other individuals (narrow equivalence range) tended to sort stimuli into many categories, the criteria of which were exacting.

The more recent work of Gardner and his colleagues has focused on further explorations of individual cognitive controls and most of these studies will be considered in subsequent sections. It should be noted, however, that two of the control principles are particularly related to the work of Witkin and Kagan. The control principle of field articulation is strongly tied to Witkin's analytical-global dimension in that the criterion measures are identical. Witkin uses a battery of tests which includes the EFT, BAT, and RFT, while Gardner employs the EFT and RFT as the principle criterion measures. The control principle of equivalence range is related to Kagan's styles of conceptualization in that both use a categorizing test as a criterion measure. Kagan employs the CST and Gardner uses the OST.

CRITICAL CHARACTERISTICS OF COGNITIVE STYLE

Individual differences in the manner in which a complex stimulus array is perceived and analyzed reflect an important dimension of cognitive style which is thought to be responsible for general differences in cognitive functioning. Four characteristics related to this dimension can be distinguished: the stability of cognitive style, developmental differences in cognitive style, sex differences in cognitive style, and intellectual differences in cognitive style. Each of these characteristics will be considered in the present section.

The Stability of Cognitive Style

The stability of an individual's cognitive style can be assessed in two ways. First, the stability of an individual's performance across situations can be evaluated; a S who responds in an analytical fashion in one situation would be expected to respond in a like manner in similar or related situations. Second, the stability of an individual's performance over time can be evaluated; a S who responds in an analytical manner would be expected to maintain this level of analysis over time.

It was pointed out in the preceding section that each of the investigators concluded that cognitive style was consistent across situations. For example, Witkin et al. (1954) presented intercorrelations between the perceptual tests as evidence indicating the stability of the field-independence dimension of cognitive style. Similarly, Kagan et al. (1963) reported that analytic performance on the CST was correlated with analytic performance in other situations such as the figure sorting task and the paired-associate task. Gardner et al. (1959) also presented intercorrelations between a variety of test situations as evidence for the stability of cognitive style. The conclusions drawn by these investigators were that an individual's cognitive style is consistent across

a variety of situations and that individual differences in cognitive style result in individual differences in cognitive functioning.

Data derived from longitudinal studies also support the contention that an individual's cognitive style remains relatively stable over a given time period. Witkin et al. (1962) reported that test-retest correlations for the perceptual battery remained relatively stable over 1 to 3 years. The correlations reported ranged from .66 to .97 for the perceptual battery. Dana and Goocher (1959) reported stability coefficients of .94 for the EFT after a 1-week interval which is in agreement with the 3-year correlation of .89 reported by Witkin et al. (1962). In a longitudinal study reported by Witkin et al. (1962) which evaluated perceptual performance of children over a 7-year period, the test-retest correlation coefficients based upon a perceptual index score (weighted score of BAT, RFT, and EFT) were .50 for males and .79 for females.

Similar observations were reported by Kagan et al. (1963) who found an indication of stability in the number of analytic responses on the CST given by third graders over a 1-year test interval. For boys, the correlation was a moderate .43 while for girls it was .70. Further research by Kagan et al. (1964) confirmed earlier findings and indicated that moderate stability was maintained over a 12-month period.

Gardner and Long (1960) examined the stability of four of the postulated cognitive controls. The criterion tests for equivalence range, focusing-scanning, leveling-sharpening, and constricted-flexible control principles were readministered to 38 Ss after a 3-year interval. The correlations between test and retest scores ranged from .36 to .75 and indicated that cognitive controls "are relatively enduring features of cognitive organization."

In summary, then, the evidence suggests that individual differences in the manner in which a stimulus complex is perceived and analyzed are relatively stable across various situations and over various time intervals. Witkin et al. (1962) also suggested that their measures of field independence remained stable even when experimental techniques designed to alter perceptual performance were employed. Neither drugs (Witkin et al., 1962) nor special training techniques (Elliott & McMichael, 1963) were successful in producing significant changes in performance on the perceptual battery.

Developmental Differences in Cognitive Style

Concern with developmental differences in cognitive style is closely related to the problem of stability. The primary question is whether a child, compared with other children his age, maintains his relative position on the continuum of cognitive style as he progresses through more advanced developmental levels. In a cross-sectional study, Witkin et al. (1954) found that younger children as a group tended to be more field dependent than older children. With increases in age, however, there was a tendency to become more field independent. This trend stabilized during early adulthood (20 years old). Furthermore, a wide range of individual differences in performance on the perceptual battery was observed at each age level, but within any given age level the distribution of performance was approximately normal. Also, performance at each age level was self-consistent. Witkin et al. (1962) cited an unpublished longitudinal study by Witkin, Goodenough, and Karp in which the same trends were observed.

Witkin et al. (1962) and Witkin (1964) suggested that a mother's level of differentiation played an important role in fostering the development of her child's cognitive style. Witkin et al. (1962) reported that the performance of a mother and her sons on several measures of differentiation was significantly correlated. Corah (1965) extended these findings by including an analysis of father and daughter performance. These results not only confirmed Witkin's findings with mothers and sons, but also indicated that the relationship between the performance of fathers and their daughters was a significant one.

Kagan and his colleagues have also reported developmental differences in conceptual style. Kagan et al. (1964) found that the number of analytic responses on the CST was an increasing linear function of age; first graders on the average produced four analytical responses while sixth graders averaged nine.

The work of Gardner and his colleagues has not considered the question of developmental differences in cognitive controls. A study by Santostefano and Paley (1964), however, suggested that the scanning-focusing and the constricted-flexible control principles followed a developmental trend similar to that observed by Witkin and Kagan.

Sex Differences in Cognitive Style

In general, the work stemming from Witkin's laboratory indicated that females as a group were more variable in their performance and more field dependent than males. Although this observation was reported to be consistent at all developmental levels, it was not until adulthood that differences between the sexes became pronounced (Witkin et al., 1954). Others (Gardner et al., 1959; Kagan et al., 1963; Kagan et al., 1964) also reported sex differences in the perception and analysis of a complex stimulus configuration.

The explanation of sex differences in measures of cognitive style is not clear. Bieri (1960) related sex differences on the EFT to parental identification and acceptance of authority and found that females who identified with their fathers were more analytical than females who identified with their mothers. Also there was some suggestion that Ss who were low in acceptance of authority were more analytical than Ss high in acceptance of authority.

Kagan et al. (1963) stated, "One implication of these sex differences takes the form of a suggestion to investigators of cognitive processes to analyze their measures separately for the sexes and to pool data only when the directions of the relationship are similar for boys and girls [p. 111]." It is for this reason that the present study was confined to male Ss.

Intellectual Differences in Cognitive Style

Early observations of a significant relationship between general intelligence and the perceptual battery suggested to Witkin et al. (1962) that the individual differences which they had been exploring might simply be a function of differences in general intelligence. This assumption was predicated on the finding that intelligence, as measured by the Revised Stanford Binet, was correlated with the perceptual index scores for boys (.57) and girls (.76). Similar observations were reported when the Wechsler Intelligence Scale for Children was used as a measure of intelligence and correlated with the perceptual index score.

A number of factor-analytic studies have examined the relationship between measures of intelligence and field independence (Goodenough & Karp, 1961; Karp, 1963; Witkin et al., 1962). In general, the results of these studies are quite consistent. Three clusters of subtests on the Wechsler have been identified in these factor analyses: one cluster represented subtests dealing with verbal comprehension; another represented subtests dealing with attention and concentration; and the third, the analytic cluster, was represented by the Block Design, Object Assembly and Picture Completion subtests. Furthermore, this analytic cluster of subtests was found to define a factor which also consisted of heavy factor loadings from measures of field independence such as the EFT, RFT and BAT. Witkin et al. (1962) and Witkin (1964) concluded that: (1) field-independent Ss are intellectually superior to field-dependent Ss only in terms of the analytical subtests—there is no difference between these two groups of Ss on the verbal comprehension and attention-concentration subtests; and (2) the ability common to the analytic measures of intelligence and to the measures of field independence is the ability to overcome an embedding context.

Similar results and conclusions are reported by Kagan and Gardner. Kagan et al. (1963) reported that the analytical style of conceptualization was not related to the verbal subtests of the California Test of Mental Maturity but was moderately correlated (.42) with the nonverbal subtests. Similar results were reported by Kagan et al. (1964) in that analytic style was positively related to the Picture Completion and Picture Arrangement subtests of the Wechsler but was not correlated with the Vocabulary and Information subtests. Gardner et al. (1960) explored the relationship between various cognitive controls and intellectual abilities and concluded that the control principle of field articulation was not related to verbal abilities but was related to various nonverbal abilities such as Thurstone's (1944) flexibility of closure.

COGNITIVE STYLE AND CONCEPT LEARNING

Individual difference variables in concept identification have received relatively little attention compared to the consideration given task variables. Bruner, Goodnow, and Austin (1956), for example, observed that individuals differed in the strategies they utilized in identifying concepts but made no attempt to relate these differences to other variables. In extensive reviews of the concept identification literature both Hunt (1962) and Bourne (1966) indicated that the role of individual differences was largely unexplored.

Although Jensen (1966) strongly advocated research on individual differences in learning,

he suggested that the area of concept learning was too complex and that the investigation of individual differences should be limited to the more elementary processes in more simple forms of learning. Jensen argued that two conditions must be met before research with individual differences can be fruitful. First, the main parameters of the phenomena must be clearly understood. Second, a source of testable hypotheses must be afforded by the theoretical development of the phenomena.

It would seem that the time is now ripe to consider the influence of cognitive style on concept identification since both of the above conditions seem to have been fulfilled. Bourne (1966) pointed out that the empirical knowledge in the area of concept learning now represents a respectable body of knowledge. Furthermore both the area of concept learning and the area of cognitive style have a sufficient body of knowledge such that the theoretical points of view afford testable hypotheses.

Data from a number of studies concerned with cognitive style suggest that a person's cognitive style influences his performance in a variety of learning tasks. Fitzgibbons, Goldberger, and Eagle (1965), for example, found that recall and recognition of social words incidentally presented was significantly correlated with field dependence. Similar findings were reported by Vaught and Ellinger (1966) in tactile form discrimination. Guetzkow (1951) found that successful performance in problem solving was correlated with successful performance on the EFT. Gardner and Long have demonstrated that many of their cognitive controls were related to serial learning (Gardner & Long, 1960, 1961; Long, 1962).

Whether the stylistic characteristic which is concerned with the manner in which an individual perceives and analyzes a complex stimulus configuration is interpreted as the ability to separate an item from the context in which it occurs as Witkin suggested, or as an ability to differentiate and analyze a complex stimulus array as suggested by Kagan, or as the ability to differentially attend to relevant aspects of the stimulus complex as suggested by Gardner, it would seem to be an important variable in concept identification. In the typical concept identification experiment which follows a reception paradigm as outlined by Bourne (1966), the S is presented a series of stimulus patterns which usually vary along several dimensions such as size, shape, and color. The S's task is to learn which dimensions define the concept and which dimensions are irrelevant to the solution of the problem. Thus it can be seen that an ability to analyze a stimulus complex would be crucial in solving concept identification problems.

Baggaley (1955) conducted an experiment which suggested that an individual's cognitive style influenced his performance on a concept identification task. A card sorting task was employed in which Ss had to sort each of 32 cards into one of two categories. One category was defined by one value from each of two dimensions while the other category represented all cards which were nonexamplars of the concept. A product moment correlation of .45 ($p < .01$) was observed between a S's concept score and the Concealed Figures Test which Gardner et al. (1960) found to be correlated with, and factorially similar to, Witkin's EFT and RFT. Thus the analytic Ss were more successful in the concept sorting task.

Similarly, Ohnmacht (1966) found that field-independent Ss were superior to field-dependent Ss in a reversal-nonreversal concept identification task regardless of the particular shift condition. Elkind, Koegler, and Go (1963) found that field-independent Ss scored significantly higher on a "perceptual concept formation task" (Shipley Abstraction Scale) than did field-dependent Ss. It was suggested that field independence was an asset in conceptual tasks which required perceptual concept formation ("The abstraction of elements and relations from things rather than from words....") and that field independence was not beneficial on tasks which required verbal concept formation ("...the abstraction of elements and relations from words rather than from things....").

Lee, Kagan, and Rabson (1963) attempted to determine whether analytic performance on the CST was associated with rate of learning concepts in third graders. Equal numbers of analytic and non-analytic responders were given a concept learning task in which analytic, relational, or inferential concepts were to be learned. The stimulus material consisted of pictures of common objects which were grouped on an analytical, relational, or inferential basis and were paired with nonsense syllables. For example, the stimulus objects representing an analytical concept such as "objects with a missing leg" were paired with the same nonsense syllable. Thus, a paired-associate procedure was followed in which Ss were shown an examplar of one of three types of concepts and were required to respond with the nonsense syllable which represented the concept. The results of this study showed that the analytic Ss learned the analytic concepts at similar rates ($r = .72$) and that they learned the

relational concepts at moderately similar rates (r = .59). The non-analytic Ss, on the other hand, learned the relational concepts at similar rates (r = .75) and the non-analytic concepts at moderately similar rates (r = .47). The analytic Ss learned the analytic concepts in the fewest trials and took the longest to learn the relational concepts. The opposite was found for the non-analytic boys who learned the relational concepts in the fewest trials and the analytic concepts in the greatest number of trials.

SUMMARY AND CRITIQUE OF RESEARCH RELATED TO COGNITIVE STYLE

On the surface it would appear that Witkin, Kagan, and Gardner were dealing with the same dimension of cognitive style. In all three cases, the primary concern was with individual differences in the manner in which a complex stimulus array was perceived and analyzed. Although the particular terms used to label this phenomenon varied within and between positions, the referent was the same. They all agreed that an individual's cognitive style is influential across a wide area of psychological functioning. For the most part, they reported the same general findings that: (1) an individual's cognitive style remains consistent across a variety of situations and over time; (2) developmental and sex differences are significant; and (3) cognitive style appears to be related to the nonverbal subtests of standard intelligence measures.

Nevertheless, a number of problems exist in the analysis, interpretation, and integration of data pertaining to cognitive style. One of the primary problems is that a variety of criterion tests were employed to identify the same cognitive style. Witkin and Gardner usually employed one measure or some combination of two or more measures from the perceptual battery while Kagan used the CST. Furthermore, Kagan et al. (1964) and Doyle (1965) reported that analytic performance on the CST was not correlated with performance on the EFT. Another basic difference between Witkin's procedures and Kagan's was that a S's performance on the CST was more a matter of preference than the ability to function analytically. Kagan et al. (1963) indicated that a given S could produce either an analytical or global response with little trouble. The opposite, however, seemed to be the case for Witkin's procedure. Elliott and McMichael (1963) demonstrated that analytic training on the RFT did not improve a non-analytic S's performance.

Wallach (1962) discussed some of the problems related to cognitive style research and offered the following suggestions: first, a multidimensional rather than a unidimensional approach should be employed in an attempt to refine the concepts of cognitive style; and second, more use should be made of moderator variables suggested by Saunders (1956) and employed by Kogan and Wallach (1964) in the study of risk taking.

In the absense of a multidimensional measure of an individual's cognitive style, the present study employed a unidimensional test which was similar to Witkin's EFT. This instrument, the Hidden Figures Test, is one of the reference tests for cognitive factors presented by French, Ekstrom, and Price (1963), and is an adaptation of the Gottschaldt Figures Test utilized by Thurstone (1944) in his factor-analytic study of perception. The task is identifying one of five simple geometric figures which is embedded in a complex pattern. The HFT is divided into two parts, each part consisting of 16 complex patterns in which the simple geometric figure to be found is always right side up and of the same size as the simple figure example. The standard instructions prescribed by the authors were followed with the exception that Ss were given 15 minutes for each of the two parts rather than 10 minutes as specified in the instructions. The HFT is a group test and is similar to a modification of Witkin's original EFT which Jackson, Messick, and Myers (1964) showed to be correlated (r = .62) with the individually administered EFT.

III
EXPERIMENT I

PROBLEM

The primary purpose of the present experiment was to determine whether an individual's cognitive style differentially influenced his performance on a standard concept identification task. It was expected that individuals experiencing difficulty in locating hidden figures on the HFT would also experience difficulty in identifying concepts in the concept identification task. It was also hypothesized that low analytic Ss would experience greater difficulty with the more complex concepts. The specific questions considered in Experiment I were:

1. In what manner is an individual's cognitive style, as identified by the HFT, related to performance on a concept identification task ?
   a. Do Ss who experience difficulty in locating a simple geometric figure in the HFT also experience difficulty with a standard concept identification task ?
   b. How do Ss in the middle range of the HFT distribution perform on a concept identification task relative to the extreme groups ?
   c. Do Ss who experience relatively little difficulty in locating a simple geometric figure in the HFT also experience little difficulty in a standard concept identification task ?
2. In what manner does the complexity of the concept identification task influence the performance of individuals who manifest different cognitive styles ?

METHOD

Subjects

The HFT was administered to 310 senior high school males and the distribution of their scores, corrected for guessing, is presented in Figure 1. The highest scores represent a greater degree of success in locating the simple figures within the complex pattern. This distribution may be conceived as a dimension of analytic responding in which the higher scores reflect an analytic cognitive style while the lower scores reflect a non-analytic or global cognitive style.

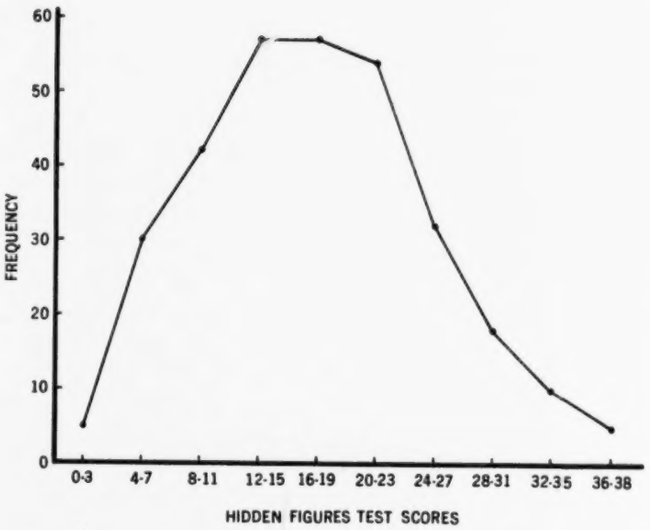

Fig. 1. Distribution of Hidden Figures Test scores for Experiment I.

Of the 310 students tested, three main groups of 30 each were selected for the experiment proper. One group, the high analytic scorers, consisted of Ss who experienced little difficulty on the HFT. Another group, the low analytic scorers, consisted of Ss who experienced great difficulty on the HFT. The third group, middle analytic scorers, consisted of Ss who were intermediate in their performance on the HFT. Data summarizing the three groups are presented in Table 1.

Stimulus Materials

The stimulus patterns utilized in Experiment I represented combinations of values from each

Table 1

Mean Scores on the Hidden Figures Test for Experiment I

Group	N	Mean	SD	Range
All Students	310	18.59	8.85	1.00 - 37.00
High Analytic	30	31.33	3.10	27.00 - 37.00
Middle Analytic	30	18.23	.72	17.00 - 18.25
Low Analytic	30	6.22	1.55	1.00 - 8.00

of seven stimulus dimensions. The dimensions and their corresponding values were: letter (H or L), number of letters (1 or 2), size of letters (large or small), color of letters (red or green), orientation of letters (upright or tilted), horizontal position of letters (left or right), and vertical position of letters (top or bottom). The total number of unique stimulus patterns was 128, since each pattern represented only one value from each of the seven dimensions These patterns served as a population from which the three levels of complexity and the two problems utilized in the experiment were constructed. The stimulus patterns were photographed and mounted as 2 × 2 in. slides. When projected, the large figures were 2 1/2 in. high and the small figures were 1 1/4 in. high.

Two problems which differed only in terms of the two relevant dimensions were used in the present experiment. Letter and letter orientation were the relevant dimensions for Problem A and horizontal position and size were the relevant dimensions for Problem B. With two relevant dimensions there were four possible combinations of the two stimulus dimensions. Thus, for Problem A the four categories were upright H, upright L, tilted H, and tilted L, and for Problem B the four categories were large left, small left, large right, and small right.

Complexity was defined in terms of the number of bits of irrelevant information contained within a problem. The three complexity levels were determined by designating one, three, or five dimensions as irrelevant. Within a problem and across the three complexity levels, the same two dimensions were relevant. In the 1-bit condition there were three dimensions which varied—the two relevant dimensions and one irrelevant dimension. Thus, a total of eight stimulus patterns was used in this condition. One value from each of the remaining four dimensions was randomly selected and held constant for each of the eight stimulus patterns. In the 3-bit condition there were five dimensions which varied—the two relevant dimensions and three irrelevant dimensions. Thus, a total of 32 stimulus patterns was used in this condition. One value from each of the remaining two dimensions was randomly selected and held constant for each of the 32 patterns. In the 5-bit condition all seven dimensions varied—two relevant dimensions and five irrelevant dimensions.

Since the stimuli were presented by means of a slide projector which could accommodate only 80 patterns, the stimulus patterns for each complexity level were selected so that 80 slides representing that level could be used. For the 1-bit condition 10 sets of the eight stimulus patterns were used and the order of presentation within each set was randomly determined. For the 3-bit condition each of the 32 patterns was used at least twice and 16 of the 32 were used three times. The order in which the stimulus patterns were presented was randomly determined within each set of 32 and within the set of 16. For the 5-bit condition 80 of the 128 stimulus patterns were selected so that every value of each dimension was represented an equal number of times. The Appendix presents a detailed description of the problems used.

Apparatus

The apparatus consisted of three units: a four-channel response unit, a tape-reader unit, and a slide projector. The four-channel response unit, illustrated in Figure 2, housed all of the electronic circuitry which controlled the sequence of events and registered Ss' responses. When the main power switch was activated, the first stimulus slide was projected on a screen and the four response buttons were illuminated. When one of the four response buttons was pressed by the Ss,

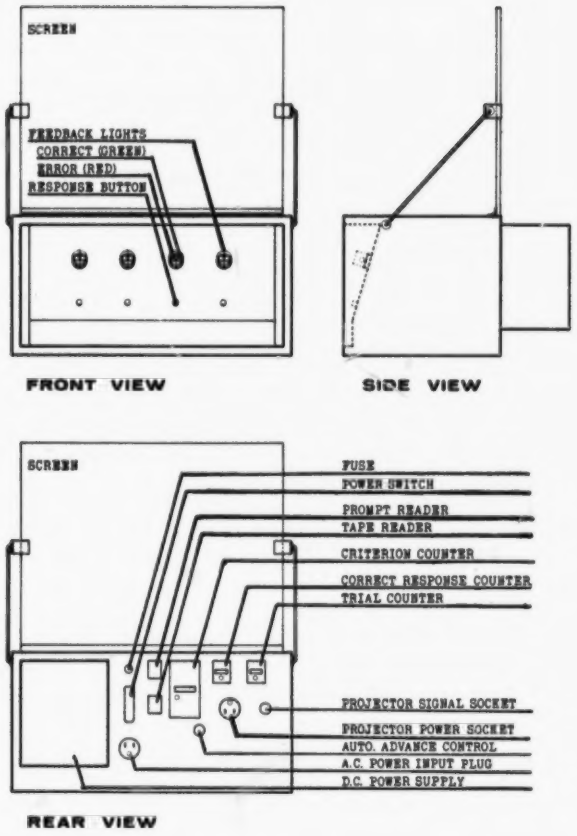

Fig. 2. Schematic of four-channel response unit.

the appropriate feedback light was illuminated, the 35mm tape advanced in the tape-reader unit, the response was recorded, and the next slide projected. Following an interval of 5 seconds the response buttons were reilluminated and the next trial begun.

The tape-reader unit consisted of four photocells and a 35mm film sprocket which was driven by a motor at the rate of 4 rpm. Holes were punched on a continuous loop of exposed 35mm film which synchronized the feedback lights with the corresponding slide. Eighty holes were punched in a 61 in. section of film, each hole being spaced 3/4 in. apart.

A Kodak Carousel slide projector was employed to present the stimulus slide to the S. The slide projector was situated on a platform 9 1/2 in. above the table and approximately 3 1/2 ft. behind the response unit. The slides when projected onto the 15 × 12 in. screen were at about eye level of the S.

Procedure

The procedure followed in the present experiment was similar to that outlined in Bourne (1957). The Ss were seated in front of the response unit and the following instructions read:[1]

> This is a concept learning experiment. For our purposes, we can say that a concept is a group of objects, all of which have something in common. A simple example of a concept would be all face cards in a deck of playing cards (face versus nonface). Other concepts may involve two or more characteristics, e.g., all red face cards. If asked to sort a deck of cards into two categories, examples and nonexamples of that concept, I'm sure you'd have no trouble doing it.
>
> You will notice a pattern on the screen in front of you. (Show several patterns.) These patterns vary in several ways. (E explains the seven or fewer dimensions and two levels of each. After S seems to have the idea, E asks S to describe one or more patterns.)
>
> In the problem we are about to begin, you are to learn how to group or classify these patterns. They will be presented one at a time and you are to respond to each by pressing one of the four buttons on this panel. Each button corresponds to a concept; the concepts are based on two important (relevant) dimensions. Each pattern is an example of 1 and only 1 of the 4 concepts that you are to learn. This is how it works. Suppose that the two relevant dimensions are size and color. You have then only (large or small) and (green or red) to consider. The four concepts would be: large green figure, small green figure, large red figure, and small red figure. You are to use the four buttons on the unit in front of you to make your choice for each pattern. In our example, button one might be the correct choice for any large red pattern, button two might be correct for any large green pattern, button three for any small red pattern, and button four for any small green pattern.
>
> Suppose that the two relevant dimensions are number and form. Can you describe a plausible solution? (E allows S time to describe the four concepts and the buttons he would press. If S cannot, then explain and give two more dimensions for another

[1] The instructions are slight modifications of those which were furnished by L. E. Bourne, Jr.

example. Continue with examples until S gets one correct.)

You won't know the two relevant dimensions or the solution to this problem to begin with, but when you press a button you are in effect saying, 'I think that particular pattern belongs in this category.' Press only one button for each pattern and press it firmly. One of two events will occur after you make your button press. If you correctly categorize the pattern, then a green light will come on above the button you pushed. If you are incorrect, then a red light will come on above the button you pushed and a green light will come on above the button you should have pressed. You may look at the pattern for as long as you wish. We are not concerned with speed but try to be as accurate as you can.

At first, you will find yourself guessing as to what the two relevant dimensions are and as to what the buttons stand for. But as you proceed you will be able to see the correct answer for several patterns; you will notice a definite relationship. The solution does not change, even though you will see many different patterns on the screen (all within the seven dimensions we talked about). You are to learn how to place each pattern into 1 of 4 groups. Are there any questions? If at any time during the experiment you have a question, feel free to ask. If there are no other questions, I will set the machine and you may start.

During the experiment the S was presented a series of stimulus patterns which corresponded to one of the three complexity levels and which was within the limits of one of the two basic problems. When a stimulus pattern was projected onto the screen, the S was required to press one of four response buttons in order to determine the category to which that particular pattern belonged. The S responded to each stimulus pattern by pressing one of the four response buttons mounted at the bottom of the response unit. If the response was correct, a green light was turned on above that response button. If the response was incorrect a red light would come on above that response button and a green light would come on above the correct response button. The significance of each button was, therefore, determined by trial-and-error.

Each response button presented one of the four possible combinations of the two dimensions which were relevant to the solution of the problem. Immediately following a S's response, the appropriate feedback light was illuminated and remained on for a 3-second interval. At the termination of this interval the tape reader would advance and a new pattern would be projected so that the S was ready to begin a new trial. The S proceeded in this fashion until he reached a criterion of 16 consecutively correct responses.

Experimental Design

The independent variables given consideration in the present experiment were task complexity, cognitive style and problems. Three levels of task complexity (1, 3, and 5 bits of irrelevant information), three levels of cognitive style (high analytic, middle analytic, and low analytic), and two problems differing with respect to the two relevant dimensions (Problem A and Problem B) were factorially combined to form a $3 \times 3 \times 2$ design. Five Ss from each of the three levels of cognitive style were randomly assigned to the problem by complexity level treatment conditions.

RESULTS AND DISCUSSION

Three response measures were obtained: total trials-to-criterion, total errors-to-criterion, and total time-to-criterion. Product moment correlation coefficients were computed between each of the response measures. The correlation between errors-to-criterion and trials-to-criterion was .957; between errors-to-criterion and time-to-criterion, .890; and between trials-to-criterion and time-to-criterion, .892. Only the data based on errors-to-criterion will be reported since the correlations between the response measures are strongly positive and because the instructions stressed accuracy rather than speed. Also, analyses of variance based on trials-to-criterion and time-to-criterion gave essentially identical results as the analysis of variance on errors-to-criterion.

The results of the analysis of variance on errors-to-criterion are summarized in Table 2. The main effect of Cognitive Style was significant ($F(2, 72) = 9.51$; $p < .01$), as were the main effects of Complexity ($F(2, 72) = 18.31$; $p < .01$), and Problems ($F(1, 72) = 20.73$; $p < .01$). Also, two interactions were significant—Cognitive Style by Problem ($F(2, 72) = 4.94$; $p < .01$) and Complexity by Problem ($F(2, 72) = 5.82$; $p < .01$).

Table 3 presents the mean errors-to-criterion

Table 2

Summary of Analysis of Variance on Errors-to-Criterion for Experiment I

Source	df	MS	F
Cognitive Style (CS)	2	7950.74	9.51**
Complexity (C)	2	15312.34	18.31**
Linear	1	30375.00	36.33**
Quadratic	1	249.69	< 1
Problems (P)	1	17333.34	20.73**
CS × C	4	523.78	< 1
CS × P	2	4133.48	4.94**
C × P	2	4867.34	5.82**
Linear (C) × P	1	9728.27	11.63**
Quadratic (C) × P	1	6.42	< 1
CS × C × P	4	696.18	< 1
Error	72	836.12	
Total	89		

** $p < .01$

Table 3

Mean Errors-to-Criterion as a Function of Cognitive Style and Problems

	Cognitive Style			
Problems	High	Middle	Low	Mean
A	31.60	50.00	86.60	56.07
B	25.13	26.13	33.67	28.31
Mean	28.37	38.07	60.13	

for cognitive style and problems. The significant main effect of Problems merely indicated that performance is dependent upon the particular dimensions relevant to problem solution. As can be seen in Table 3, Ss solving Problem B committed fewer errors than Ss solving Problem A at each level of cognitive style. Furthermore, it should be noted that the high analytic Ss made fewer errors than the middle analytic Ss who in turn made fewer errors than the low analytic Ss and that this trend was consistent across both problems.

Subsequent analysis of the Cognitive Style by Problem interaction involved mean comparisons between cognitive style levels for each problem separately. For Problem A, the F test between cognitive style means was significant ($F(2, 72) = 8.57$; $p < .01$). Furthermore, it was found that high analytic Ss and middle analytic Ss differed significantly from the low analytic Ss ($t = 5.21$ and $t = 3.46$, respectively; $df = 72$; $p < .01$), but that the middle and high analytic Ss did not differ significantly from one another ($t = 1.74$). For Problem B, the F test between cognitive style means was not significant ($F < 1$). Thus, it may be concluded that an individual's cognitive style significantly influences concept identification, but only when the conditions employed for Problem A are met.

The significant main effect of Problems was an unexpected finding. Subjects found Problem

B, in which size and horizontal position were the relevant dimensions, easier to solve than Problem A, in which letter and letter orientation were the relevant dimensions. A number of other concept identification studies have reported significant differences due to problems which differed only in terms of the particular dimensions which were relevant to problem solution (Archer, 1962; Bourne & Pendleton, 1958; Heidbreder, 1948). Frequently the salience or dominance of the particular relevant dimensions has been suggested as a possible variable influencing the difference between problems, but to date no satisfactory explanation has been advanced to account for why one problem is easier to learn than another.

In the present experiment, however, one possible interpretation of the Problem effect involves compatible stimulus-response relations in the two problems. For Problem B, the four concepts and their corresponding response button assignments were: (1) large left, (2) small left, (3) large right, and (4) small right. The assignment of the left value of the horizontal position dimension to the two response buttons on the S's left resulted in a situation high in stimulus-response compatibility (Fitts & Seeger, 1953). The four concepts and their response button assignments for Problem A, however, did not involve any noticeable compatibility relations and therefore could be considered low in stimulus-response compatibility. In view of this interpretation then, it is possible that superiority of Problem B over Problem A is attributable to the high degree of stimulus-response compatibility in Problem B.

This interpretation receives further support in terms of the Cognitive Style by Problem interaction, which is presented graphically in Figure 3. It can be seen that Problem B resulted in fewer errors regardless of cognitive style. For the high analytic Ss the difference between the two problems was minimal and non-significant (t = <1), but for the low analytic Ss the difference was maximal and significant (t = 5.01; df = 72; $p < .01$). This finding suggests that when stimulus-response compatibility is high the influence of an individual's cognitive style is negligible, but when stimulus-response compatibility is low, the low analytic Ss experience greater difficulty in identifying the concepts.

Table 4 presents the mean errors-to-criterion for Complexity and Problems. The significant main effect of Complexity indicated that performance was an increasing function of the complexity of the concept identification problems. An orthogonal polynomial analysis applied to this function indicated that the linear component of variation was significant ($F(1, 72) = 36.33$; $p < .01$). These findings are consistent with the results of Archer, Bourne and Brown (1955), Bourne (1957), and Bourne and Haygood (1960).

The individual cell means for the Complexity by Problem interaction which are presented in Table 4 are illustrated graphically in Figure 4.

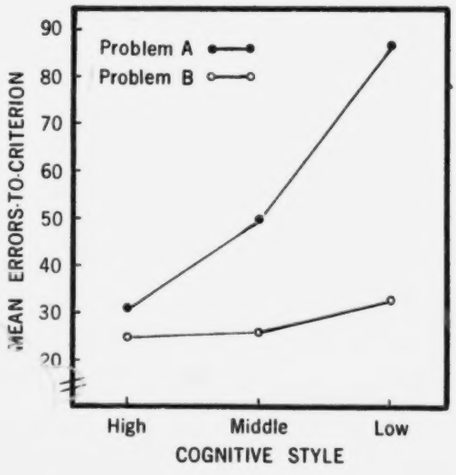

Fig.3. Mean errors-to-criterion for problems as a function of cognitive style.

Table 4

Mean Errors-to-Criterion as a Function of Complexity and Problems

	Complexity			
Problems	1	3	5	Mean
A	22.20	53.33	92.67	56.07
B	19.53	26.33	39.07	28.31
Mean	20.87	39.83	65.87	

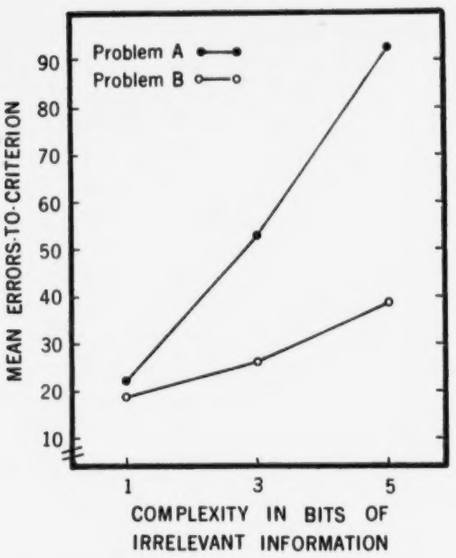

Fig. 4. Mean errors-to-criterion for problems as a function of amount of irrelevant information.

It can be seen that the number of errors-to-criterion, for both problems, increased linearly with increases in complexity. The rate of increase for Problem A, however, was greater than for Problem B. Subsequent analysis of this interaction involved an orthogonal polynomial analysis and indicated that the linear component was significant ($F(1, 72) = 11.63$; $p < .01$).

Thus, the interaction resulted from differences between the linear trends of the two problems across the levels of complexity.

In summary, an individual's cognitive style was found to influence his concept identification performance. Individuals identified as analytical on the HFT experienced little difficulty in identifying concepts while Ss who experienced difficulty in locating the simple figure in the HFT (low analytic) experienced considerable difficulty in concept identification. Individuals falling in the middle of the HFT distribution performed at an intermediate level of performance on the concept identification task. The hypothesized interaction between Cognitive Style and Complexity was not supported by the data. If, however, it can be assumed that a problem high in stimulus-response compatibility is less complex than a problem low in stimulus-response compatibility, then there was some evidence suggesting that complexity does interact with cognitive style. This evidence was provided by a significant interaction of Problems by Cognitive Style which indicated that the influence of cognitive style was negligible for the problem high in stimulus-response compatibility (low level of complexity), but resulted in poorer performance on the part of the low analytic Ss when the problem was low in stimulus-response compatibility (high level of complexity).

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IV
EXPERIMENT II

PROBLEM

The primary purpose of Experiment II was to determine whether the deficit in concept identification by the low analytic Ss in Experiment I could be overcome through the use of two training procedures, verbalization and prompting.

Overt verbalization of stimulus attributes either in a pretraining session or during task acquisition has been reported to facilitate learning (Weir & Stevenson, 1959; Wolff, 1967). Tighe and Tighe (1966) suggested that facilitation resulting from verbalization is a function of ". . . forcing the S to differentiate the relevant variables of stimulation [p. 364]." It would be expected, therefore, that overt verbalization of the stimulus dimension during concept identification would facilitate learning the concept. Furthermore, it would be expected that low analytic Ss would derive a greater benefit from the verbalization training than would the high analytic Ss because the high analytic Ss presumably differentiate the stimulus attributes in the absence of any specific task requirement such as verbalization.

Prompted training involves the presentation of a cue which provides a S with information concerning the correct alternative prior to his responding. This training procedure also has been found to facilitate learning (Cook & Spitzer, 1960; Fletcher, Davis, Orr, & Ross, 1965; Hawker, 1967; Kaess & Zeaman, 1960; Sidowski, Kopstein, & Shillestad, 1961). Thus, it was expected that prompted training would facilitate subsequent performance in concept identification.

The specific questions which this experiment sought to answer were:

1. Does verbalizing the stimulus values for each instance aid a S in identifying a concept?
2. Does informing the S of the correct response prior to his responding (prompting) aid him in identifying a concept on subsequent unprompted trials?
3. Do the training procedures either alone or combined differentially influence performance of Ss functioning under different cognitive styles?

METHOD

Subjects

The HFT was administered to 323 senior high school males. The over-all distribution of these scores is presented in Figure 5. Forty students from the analytic end of the distribution and 40 students from the non-analytic end of the distribution were selected for the experiment proper. As in Experiment I, it was assumed that the high analytic S reflected an analytic cognitive style and the non-analytic S reflected a global cognitive style. Data summarizing the two groups are presented in Table 5.

It should be noted that there were no significant differences between the samples of the first and second experiments when the normative

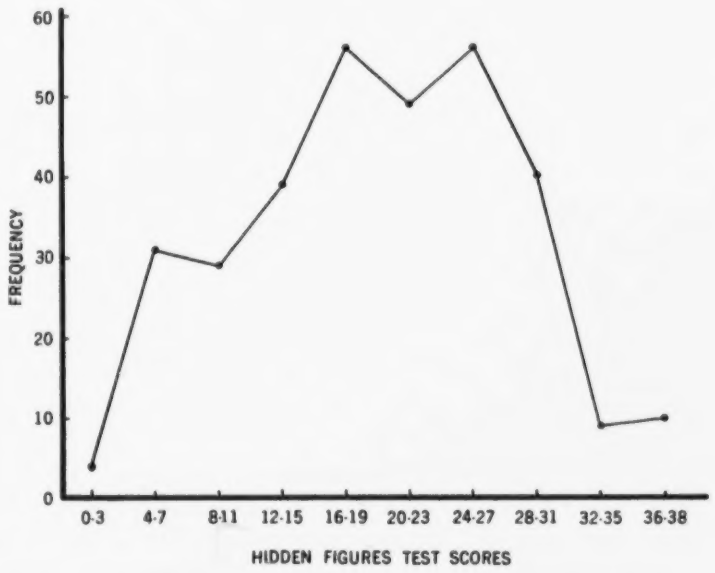

Fig. 5. Distribution of Hidden Figures Test scores for Experiment II.

data were compared. There was no significant difference between the means of over-all test distributions ($t = 1.77$, $df = 631$, $p > .05$). Furthermore, there were no significant differences between the means of the high analytic groups ($t = 1.21$, $df = 68$, $p > .05$) or between the means of the low analytic groups ($t = 1.71$, $df = 68$, $p > .05$).

Stimulus Materials

The stimulus materials were the same as those used in Experiment I with the following exception. Because considerably greater performance decrement was observed under the most complex problems (5 bits of irrelevant information) in Experiment I, only this problem was used in the present experiment since it was felt that this level of complexity would be the most sensitive measure of the training procedures. Problem A was identical to Problem A of Experiment I and consisted of letter and letter orientation as the relevant dimensions. In order to eliminate the problem of stimulus-response compatibility associated with Problem B in Experiment I, a different problem was employed which consisted of number and vertical position as the relevant dimensions.

Procedure

With the following exception, the procedure was identical to that described for Experiment I. Subjects receiving the prompted training were instructed that for the first 24 trials the correct response button would be illuminated prior to their response. They were further instructed that they could examine the stimulus pattern for as long as necessary before responding. Subjects proceeded in this fashion until 24 patterns had been presented. Following the 24 prompted trials, the Ss proceeded in a trial-and-error fashion until the criterion of 16 consecutively correct responses was reached.

Subjects receiving the verbalization training were instructed to describe all of the values present in each of the stimulus patterns before responding. In the event that a S failed to identify all seven values, the E indicated to the S that he had omitted one or more of the values. Then, if the S could not remember a value the E would tell him. Subjects continued to name all of the stimulus values on every trial until reaching criterion.

Experimental Design

The experimental design consisted of two levels of cognitive style (high or low analytic), two levels of prompted training (24 prompted trials or no prompted trials), two levels of verbal training (verbalization of all values per instance or no verbalization), and two problems which were factorially combined to form a $2 \times 2 \times 2 \times 2$ design. Ten Ss from each level of cognitive style were randomly assigned to one of four training conditions. The four training conditions were: a verbal-prompt condition, a verbal only condition, a prompt only condition, and a control condition which received no prompting or no verbalization (i.e., standard condition used in most concept identification experiments).

RESULTS AND DISCUSSION

Two response measures were obtained: errors-to-criterion and trials-to-criterion. Since Ss in the prompt conditions made no errors during the first 24 trials, the errors-to-criterion measure was computed for all Ss beginning with trial 25. Time-to-criterion was not employed as a dependent variable in this experiment because Ss receiving the verbal training conditions were ob-

Table 5

Mean Scores on the Hidden Figures Test for Experiment II

Group	N	Mean	SD	Range
All Students	323	19.83	8.65	2.00 - 37.00
High Analytic	40	32.26	3.17	27.00 - 37.00
Low Analytic	40	7.02	2.29	2.00 - 11.50

Table 6

Summary of Analysis of Variance on Errors-to-Criterion for Experiment II

Source	df	MS	F
Cognitive Style (CS)	1	12650.45	9.77*
Prompted Training (Pt)	1	3276.80	2.53
Verbal Training (Vt)	1	105.80	< 1
Problems (Pr)	1	480.20	< 1
CS × Pt	1	.45	< 1
CS × Vt	1	638.45	< 1
CS × Pr	1	36.45	< 1
Pt × Vt	1	13005.00	10.05*
Pt × Pr	1	245.00	< 1
Vt × Pr	1	540.80	< 1
CS × Pt × Vt	1	2101.25	1.62
CS × Pt × Pr	1	151.25	< 1
CS × Vt × Pr	1	328.05	< 1
Pt × Vt × Pr	1	1920.80	1.48
CS × Pt × Vt × Pr	1	170.05	< 1
Error	64	1293.78	
Total	79		

*$p < .05$

viously required to spend more time per instance than Ss not receiving the verbal training. Because the product moment correlation between errors-to-criterion and trials-to-criterion was large and positive (.951), only the data based on errors-to-criterion will be presented. Analysis of variance based on trials-to-criterion, however, was performed and indicated essentially identical results as did the analysis of errors-to-criterion.

The results of the analysis of variance on errors-to-criterion are presented in Table 6. The main effect of Cognitive Style was significant ($F(1,64) = 9.77$; $p < .05$), as was the interaction of Prompted Training by Verbal Training ($F(1,64) = 10.05$; $p < .05$).

The significant main effect of Cognitive Style indicated that high analytic Ss committed fewer errors in identifying the concepts than did low analytic Ss. The mean number of errors for the high and low analytic Ss was 41.72 and 66.87, respectively. The significance of the cognitive style source of variance was consistent with the results of the first study and indicated that performance in concept identification is related to the ability to identify embedded figures in the HFT—Ss who experience difficulty on the HFT also experience difficulty in concept identification.

Based upon the cognitive style literature, it may be suggested that Ss who experience difficulty in separating a simple geometric pattern from an embedding context also experience difficulty in separating relevant from irrelevant dimensions in concept identification. Several other alternatives, however, can be advanced to account for the low analytic S's difficulty in concept identification. First, it is possible that low analytic Ss are unable to remember individual instances as well as high analytic Ss. Second, it may be that low analytic Ss are unable to utilize feedback, to process information, or to test hypotheses as effectively as high analytic Ss. The explicit reason for this difficulty, however, must await further research.

Table 7 presents the means involved in the significant Prompted Training by Verbal Training interaction. Subsequent analyses of the differences between the cell means revealed that the prompt only condition and the verbal only condition differed significantly from the control condition ($t = 3.37$ and $t = 2.04$, respectively; $df = 64$; $p < .05$), but that the verbal-prompt condition did not differ significantly from the control condition ($t < 1$). These results permitted the conclusion that either verbal training or prompted training leads to superior concept identification, but when both training procedures are employed (verbal-prompt

Table 7

Mean Errors-to-Criterion as a Function of Prompted Training and Verbal Training

	Prompted Training		
Verbal Training	Prompt	No Prompt	Mean
Verbalization	61.80	49.10	55.45
No Verbalization	34.00	72.30	53.15
Mean	42.90	60.70	

condition) performance does not differ from the control condition (no training).

The results concerning the Prompted Training by Verbal Training interaction are extremely difficult to account for in light of the present data, and therefore any explanation of these results must be viewed as highly speculative and tentative until more is known about training procedures in concept identification. The following discussion, then, will merely serve to raise questions rather than to answer them.

It was found that Ss required to verbalize the stimulus values which were present in each stimulus pattern (verbal only condition), identified the concept with fewer errors than Ss who did not verbalize the stimulus values (control condition). It may be that verbalization insures that a S will not forget or overlook any of the stimulus dimensions or it may be that verbalization forces the S to differentiate the relevant variables of stimulation as Tighe and Tighe (1966) suggested. Further research is indeed needed to determine why the verbal only condition facilitates concept identification.

It was also found that Ss who received prompted training (prompt only condition) identified the concept with fewer errors than Ss who did not receive prompted training (control condition). As in the verbal only condition, it may be suggested that the prompt only condition aids concept identification by reducing the memory requirements of the task and by providing an otpimum amount of time for information processing. In the absence of a prompt the S does not know which category is correct until after he has responded. Thus he must respond and, in a relatively short interval, associate the correct category with the values of that instance. Subjects receiving the prompt only condition, however, know which category is correct and therefore have an unlimited amount of time to associate the category with the values of that instance.

It was observed that Ss receiving the prompt only condition had identified at least one of the two relevant dimensions by the end of the first block of eight trial-and-error trials. If a S knows one of the two relevant dimensions, then the probability of a correct response is .50. If, however, the S does not know either of the relevant dimensions the probability of a correct response is .25. Out of a possible 160 correct responses over the first eight trials, the prompt only condition had 82 or 51% correct responses. In contrast, the control condition had 53 out of a possible 160 correct responses or 33% correct responses. Therefore it seems that Ss receiving the prompt only condition were able to identify one of the two relevant dimensions during the prompted training.

Since the verbal only and the prompt only training procedures were found to facilitate concept learning, it would be expected that combining verbal and prompted training would result in greatly facilitated performance. It was observed, however, that verbalization before the correct category was known (verbal only condition) aided or facilitated concept identification, but that verbalization after the correct category was known (verbal-prompt condition) interfered with efficient concept identification. The reason for this poor performance, however, is not at all clear.

The failure to find any significant interaction involving cognitive style and either or both of the training procedures leads to the conclusion that these training procedures do not differentially influence concept identification for individuals manifesting different cognitive styles. This conclusion, however, may be an artifact of the particular methodology employed in the present study. It would be expected that if the training procedures were to differentially influence the cognitive style levels the influence would be reflected in the rate at which the concepts were learned. In the present study, as in the majority of concept identifica-

tion studies, performance was evaluated in terms of total errors-to-criterion or total trials-to criterion. It is entirely possible that these dependent variables are not sensitive enough to detect the exact nature of these training procedures. Furthermore, it is possible that training procedures and cognitive style do interact in terms of the rate at which the concepts are learned, but that when this interaction is evaluated in terms of total scores the differences are not reflected. An interaction might be observed if all Ss were given a fixed number of trials and performance were evaluated in terms of performance over blocks of trials.

In summary, individuals identified as high analytic solved the concept identification problem with greater ease than did the low analytic Ss. These results are in essential agreement with the findings of Experiment I. It was also found that the prompt only and the verbal only training conditions resulted in significantly better concept identification than the control condition (no training). It was suggested that the poor performance of the verbal-prompt condition was due to the fact that verbalizing the stimulus values before the correct category is known results in efficient concept identification, but that verbalizing the stimulus values after the correct category is known results in interference.

V

SUMMARY AND CONCLUSIONS

The influence of an individual's cognitive style in concept identification was studied as a function of task complexity in one experiment and as a function of two training procedures in another experiment. In both studies, cognitive style was operationally defined in terms of an individual's performance on the HFT. The concept identification task required Ss to classify figural patterns, which could vary along as many as seven bi-valued dimensions, into four categories. Each category represented one of four possible combinations of values from two relevant dimensions. Subjects were tested individually and run to a criterion of 16 consecutively correct responses.

The specific questions considered in Experiment I were:

1. In what manner is an individual's cognitive style related to performance on a concept identification task ?
2. In what manner does the complexity of the concept identification task influence performance of individuals who manifest different cognitive styles ?

The essential findings of Experiment I were:

1. High analytic Ss made fewer errors than did middle analytic S who in turn made fewer errors than low analytic Ss.
2. Performance in terms of errors-to-criterion was an increasing linear function of the complexity of the problem.
3. The hypothesized interaction of Cognitive Style with Complexity was not significant.

The specific questions considered in Experiment II were:

1. Does verbalizing the stimulus values for each instance aid a S in identifying a concept ?
2. Does informing the S of the correct response prior to his responding (prompting) aid him in identifying a concept on subsequent unprompted trials ?
3. Do the training procedures either alone or combined differentially influence performance of Ss functioning under different cognitive styles ?

The essential findings of Experiment II were:

1. High analytic Ss committed significantly fewer errors than the low analytic Ss.
2. Verbalizing the stimulus values for each instance faciliated concept identification, but only in the absence of prompted training.
3. Prompted training facilitated concept identification, but only in the absence of verbal training.
4. The training procedures did not differentially influence performance of Ss functioning under different cognitive styles.

In conclusion, these studies demonstrated that cognitive style is an important individual difference variable which exerts a marked degree of influence in concept identification. The relevance of this finding to education is important in view of the current emphasis given to individualized instruction (Klausmeier & Goodwin, 1966). This finding would suggest that cognitive style is relevant when working with individuals in an instructional situation. It would follow that non-analytic students would require assistance in differentiating a stimulus complex to a greater extent than would high analytic children. Certainly further consideration should be given to the individual difference variable of cognitive style both at empirical and theoretical levels. It was also demonstrated that training procedures such as prompting and verbalizing can be effectively used in teaching concepts to both high and low analytic individuals. It is hoped that the studies reported in this paper will help to stimulate further research pertaining to individual differences and training procedures in concept identification so that we may progress toward greater efficiency in classroom learning.

APPENDIX

Description for Problems for Experiment I

Dimension	Value	Problem A Complexity 1	A Complexity 3	A Complexity 5	Problem B Complexity 1	B Complexity 3	B Complexity 5
Number	One	C	I	I	-	I	I
	Two	-	I	I	C	I	I
Size	Large	I	I	I	R	R	R
	Small	I	I	I	R	R	R
Color	Red	-	-	I	C	C	I
	Green	C	C	I	-	-	I
Letter Orientation	Upright	R	R	R	-	I	I
	Tilted	R	R	R	C	I	I
Letter	H	R	R	R	I	I	I
	L	R	R	R	I	I	I
Horizontal Position	Left	C	I	I	R	R	R
	Right	-	I	I	R	R	R
Vertical Position	Upper	-	-	I	-	-	I
	Lower	C	C	I	C	C	I

R = Relevant
I = Irrelevant
C = Constant
- = Absent

REFERENCES

Archer, E. J. Concept identification as a function of obviousness of relevant and irrelevant information. Journal of Experimental Psychology, 1962, 63, 616-620.

Archer, E. J., Bourne, L. E., Jr., & Brown, F. G. Concept identification as a function of irrelevant information and instructions. Journal of Experimental Psychology, 1955, 49, 153-164.

Asch, S. E., & Witkin, H. A. Studies in space orientation: I. Perception of the upright with displaced visual fields. Journal of Experimental Psychology, 1948, 38, 325-337. (a)

Asch, S. E., & Witkin, H. A. Studies in space orientation: II. Perception of the upright with displaced visual fields and with body tilted. Journal of Experimental Psychology, 1948, 38, 455-477. (b)

Baggaley, A. R. Concept formation and its relation to cognitive variables. Journal of General Psychology, 1955, 52, 297-306.

Bieri, J. Parental identification, acceptance of authority, and within-sex differences in cognitive behavior. Journal of Abnormal and Social Psychology, 1960, 60, 76-79.

Bourne, L. E., Jr. Effects of delay of information feedback and task complexity on the identification of concepts. Journal of Experimental Psychology, 1957, 54, 201-207.

Bourne, L. E., Jr. Human conceptual behavior. Boston: Allyn & Bacon, 1966.

Bourne, L. E., Jr., & Haygood, R. C. Effects of intermittent reinforcement of an irrelevant dimension and task complexity upon concept identification. Journal of Experimental Psychology 1960, 60, 371-75.

Bourne, L. E., Jr., & Pendleton, R. B. Concept identification as a function of completeness and probability of information feedback. Journal of Experimental Psychology, 1958, 56, 413-420.

Bruner, J. S., Goodnow, J. J., & Austin, G. A. A study of thinking. New York: Wiley, 1956.

Cook, J. O., & Spitzer, M. E. Supplementary report: Prompting versus confirmation in paired-associate learning. Journal of Experimental Psychology, 1960, 59, 275-276.

Corah, N. L. Differentiation in children and their parents. Journal of Personality, 1965, 33, 300-308.

Dana, R. H., & Goocher, B. Embedded-figures and personality. Perceptual and Motor Skills, 1959, 9, 99-102.

Doyle, J. F. The effect of cognitive style on the ability to attain concepts and to perceive embedded figures. Unpublished doctoral dissertation, University of Florida, 1965.

Elkind, D., Koegler, R. R., & Go, E. Field independence and concept formation. Perceptual and Motor Skills, 1963, 17, 383-386.

Elliott, R., & McMichael, R. E. Effects of specific training on frame dependence. Perceptual and Motor Skills, 1963, 17, 363-367.

Faterson, H. F. Articulateness of experience: An extension of the field-dependence-independence concept. In S. Messick & J. Ross (Eds.), Measurement in personality and cognition. New York: Wiley, 1962. Pp. 171-181.

Fitts, P. M., & Seeger, C. M. S-R compatibility: Spatial characteristics of stimulus and response codes. Journal of Experimental Psychology, 1953, 46, 199-210.

Fitzgibbons, D., Goldberger, L., & Eagle, M. Field dependence and memory for incidental material. Perceptual and Motor Skills, 1965, 21, 743-749.

Fletcher, H. J., Davis, J. K., Orr, B. M., & Ross, P. Prompted versus trial-and-error initial object discrimination learning by monkeys, retardates, and preschool children. Psychonomic Science, 1965, 2, 59-60.

French, J. W., Ekstrom, R. B., & Price, L. A. Manual for kit of reference tests for cognitive factors. Princeton, New Jersey: Educational Testing Service, 1963.

GPO 806-346-3

Gardner, R. W. Cognitive styles in categorizing behavior. Journal of Personality, 1953, 22, 214-233.

Gardner, R. W. Cognitive controls in adaptation: Research and measurement. In S. Messick & J. Ross (Eds.), Measurement in personality and cognition. New York: Wiley, 1962. Pp. 183-198.

Gardner, R. W. The development of cognitive structures. In C. Scheerer (Ed.), Cognition: Theory, research, promise. New York: Harper & Row, 1964. Pp. 147-171.

Gardner, R. W., Holzman, P. S., Klein, G. S., Linton, H., & Spence, D. P. Cognitive control: A study of individual consistencies in cognitive behavior. Psychological Issues, 1959, 1 (4, Whole No. 8).

Gardner, R. W., Jackson, D. N., & Messick, S. J. Personality organization in cognitive controls and intellectual abilities. Psychological Issues, 1960, 2 (4, Whole No. 8).

Gardner, R. W., & Long, R. I. Leveling-sharpening and serial learning. Perceptual and Motor Skills, 1960, 10, 179-185.

Gardner, R. W., & Long, R. I. Field articulation in recall. Psychological Record, 1961, 11, 305-310.

Goodenough, D. R., & Karp, S. A. Field dependence and intellectual functioning. Journal of Abnormal and Social Psychology, 1961, 63, 241-246.

Guetzkow, H. An analysis of the operation of set in problem-solving behavior. Journal of General Psychology, 1951, 45, 219-244.

Hawker, J. R. The effects of training procedure and variations in the P-A paradigm on the learning of paired-associates. Psychonomic Science, 1967, 7, 347-348.

Heidbreder, E. The attainment of concepts: VI. Exploratory experiments on conceptualization at the perceptual levels. Journal of Psychology, 1948, 26, 193-216.

Hunt, E. B. Concept learning: An information processing problem. New York: Wiley, 1962.

Jackson, D. N., Messick, S., & Myers, C. T. Evaluation of group and individual forms of embedded-figures measures of field-independence. Educational and Psychological Measurement, 1964, 24, 177-192.

Jensen, A. R. Individual differences in concept learning. In H. J. Klausmeier & C. W. Harris (Eds.), Analyses of concept learning. New York: Academic Press, 1966. Pp. 139-154.

Kaess, W., & Zeaman, D. Positive and negative knowledge of results on a Pressey-type punchboard. Journal of Experimental Psychology, 1960, 60, 12-17.

Kagan, J. Reflection-impulsivity and reading ability in primary grade children. Child Development, 1965, 36, 609-628.

Kagan, J., Moss, H. A., & Sigel, I. E. Psychological significance of styles of conceptualization. Monographs of the Society for Research in Child Development, 1963, 28 (2, Whole No. 86), 73-112.

Kagan, J., Rosman, B. L., Day, D., Albert, J., & Phillips, W. Information processing in the child: Significance of analytic and reflective attitudes. Psychological Monographs, 1964, 78 (1, Whole No. 578).

Karp, S. A. Field dependence and overcoming embeddedness. Journal of Consulting Psychology, 1963, 27, 294-302.

Klausmeier, H. J., & Goodwin, W. Learning and human abilities. (2nd ed.) New York: Harper & Row, 1966.

Klein, G. S. Need and regulation. In M. R. Jones (Ed.), Nebraska symposium on motivation. Lincoln: University of Nebraska Press, 1954. Pp. 224-274.

Kogan, N., & Wallach, M. A. Risk taking: A study in cognition and personality. New York: Holt, Rinehart & Winston, 1964.

Lee, L. C., Kagan, J., & Rabson, A. Influence of a preference for analytic categorization upon concept acquisition. Child Development, 1963, 34, 433-442.

Long, R. I. Field-articulation as a factor in verbal learning and recall. Perceptual and Motor Skills, 1962, 15, 151-158.

Ohnmacht, F. W. Effects of field independence and dogmatism on reversal and nonreversal shifts in concept formation. Perceptual and Motor Skills, 1966, 22, 491-497.

Santostefano, S., & Paley, E. Development of cognitive controls in children. Child Development, 1964, 35, 939-949.

Saunders, D. R. Moderator variables in prediction. Educational and Psychological Measurement, 1956, 16, 209-222.

Sidowski, J. B., Kopstein, F. F., & Shillestad, I. J. Prompting and confirmation variables in verbal learning. Psychological Reports, 1961, 8, 401-406.

Thurstone, L. L. A factorial study of perception. Chicago: University of Chicago Press, 1944.

Tighe, L. S., & Tighe, T. J. Discrimination learning: Two views in historical perspective. Psychological Bulletin, 1966, 66, 353-370.

Vaught, G. M., & Ellinger, J. Field-dependence and form discrimination. Psychonomic Science, 1966, 6, 357-358.

Wallach, M. A. Active-analysis vs. passive global cognitive functioning. In S. Messick

& J. Ross (Eds.), Measurement in personality and cognition. New York: Wiley, 1962. Pp.199–215.

Weir, M. W., & Stevenson, H. W. The effect of verbalization in children's learning as a function of chronological age. Child Development, 1959, 30, 143–149.

Witkin, H. A. The nature and importance of individual differences in perception. Journal of Personality, 1949, 18, 145–170. (a)

Witkin, H. A. Perception of body position and of the position of the visual field. Psychological Monographs, 1949, 63 (7, Whole No. 302). (b)

Witkin, H. A. Origins of cognitive style. In C. Scheerer (Ed.), Cognition: Theory, research, promise. New York: Harper & Row, 1964. Pp. 172–205.

Witkin, H. A. Some implications of research on cognitive style for problems of education. Archivio di Psicologia, Neurologia e Psichiatria, 1965, 26, 27–55.

Witkin, H. A., & Asch, S. E. Studies in space orientation: III. Perception of the upright in the absence of a visual field. Journal of Experimental Psychology, 1948, 38, 603–614. (a)

Witkin, H. A., & Asch, S. E. Studies in space orientation: IV. Further experiments on perception of the upright with displaced visual fields. Journal of Experimental Psychology, 1948, 38, 762–782. (b)

Witkin, H. A., Dyk, R. B., Faterson, H. F., Goodenough, D. R., & Karp, S. A. Psychological differentiation. New York: Wiley, 1962.

Witkin, H. A., Lewis, H. B., Hertzman, M., Machover, K., Meissner, P. B., & Wapner, S. Personality through perception. New York: Harper, 1954.

Wolff, J. L. Effects of verbalization and pretraining on concept attainment by children in two mediation categories. Journal of Educational Psychology, 1967, 58, 19–26.

GPO 806–346–2